THE ROLE OF MATERNAL TOUCH ON LANGUAGE DEVELOPMENT IN CHILDREN

CHOI SZE PUI

(B.A.), University of Minnesota, Twin-Cities

A THESIS SUBMITTED

FOR THE DEGREE OF MASTER OF SOCIAL SCIENCE

DEPARTMENT OF PSYCHOLOGY

NATIONAL UNIVERSITY OF SINGAPORE

2014

DECLARATION

I hereby declare that this thesis is my original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in my thesis.

This thesis has also not been submitted for any degree in any university previously.

_____

Choi Sze Pui

20 March 2015

Acknowledgments

I would like to express my deepest and utmost gratitude to my supervisor, Dr. Annett Schirmer, for accepting me as her Masters student, and for her immeasurable patience towards me. I have learned so much under your guidance, and I am forever indebted to you for your kindness, understanding, and selflessness in supervising me.

I would also like to thank my co-supervisor, Dr. Trevor Penney, for also accepting me as his Masters student, and the advice throughout my graduate journey.

This thesis would not have been possible without the support and guidance of our collaborators, Dr. Jens Brauer, and Tanja Poulain from the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig. I am very grateful for all the assistance throughout this project.

I would also like to thank research assistants Aliya Suhadar, Angeline Chua, Carl Yeo, Cui Shan Seow, Darren Yeo, Di Mo, Eugene Teng, Genevieve Swee, Han Zi Teo, Ong Eng Yian, Steffina Rukavina, Stella Guldner, and Tan Yia Chin for their help in video coding.

To my colleagues in the Brain and Behavior Lab, I am honored to have worked and played with you. To Christy, in particular, your friendship has brought me much joy.

To my family, and dearest friends, your words of encouragement serve to spur me on. To the love of my life, you are the brightest light in my darkest times.

Though the fig tree does not bud
and there are no grapes on the vines,
though the olive crop fails
and the fields produce no food,
though there are no sheep in the pen
and no cattle in the stalls,
yet I will rejoice in the LORD,
I will be joyful in God my Savior.
-Habakkuk 3:17-19

Contents

Summary

As with all aspects of human development, language development is characterized by individual differences. Among the many environmental factors that influence language development, maternal responsiveness is most reliably associated with higher receptive language scores. This thesis was most interested in examining maternal touch, one specific indicator of maternal responsiveness, in its relation to child language development. While studies that looked into the relationship between maternal touch and language are scarce, indirect evidence from studies on motor, cognitive, and social development points towards a possibility that maternal touch might be beneficial to child language development. In order to examine this possibility, this study recorded and analyzed tactile interactions between mothers and their 2 and 5 year old children during a structured play session lasting about 10 minutes. Touch initiated by the mother, as well as maternal speech as the control behavior, were then examined with respect to their relationship with the child's speech.

Results failed to show the expected positive link between maternal touch and child speech. Instead, there was a significant negative relationship between the maternal instrumental touch subtype "holding" and child mean length utterance for the 2 year olds. There was also a marginal negative relationship between maternal instrumental touch subtype "pushing" and child mean length utterance for the 5 year olds. Maternal speech frequency was negatively correlated with child utterance length in both age groups. Moreover, the only maternal behavior that seemed to promote language development was maternal utterance

length. Longer utterances from the mother concurred with longer utterances in 2 year old children.

These results suggest that maternal touch may not directly promote language development in the short term. Rather, by providing the foundation for mother-child bonding and more general aspects of social development, touch may contribute to how children acquire linguistic sophistication later in life.

List of Tables

List of Figures

List of Abbreviations

ANOVA Analysis of Variance

FRAKIS Fragebogen zur frühkindlichen Sprachentwicklung

ICC Intra-class correlation

IRR Inter-rater reliability

RA Research assistant

r_s Spearman's Rho

SD Standard deviation

TSVK Test zum Satzverstehen von Kindern

1. Introduction

Just like all aspects of human development, language development is characterized by individual differences. While there are children with vocabularies as large as 494 words at twenty months (Dale, Bates, Reznick and Morriset, 1989), others produce only a fraction of that. A factor contributing to this variation right from birth is the mother and the behaviors she directs at her infant. While past research explored aspects of this behavior, little is known about the effects of maternal touch. Specifically, the question as to whether there is a positive relationship between the frequency of maternal touch and child language development is relatively unknown. The following paragraphs provide a review of the literature leading up to this question, detailing current insights into the milestones of language development, and known inter-individual differences. Lastly, this introduction explores touch as a maternal behavior of potential relevance.

Language development in infants begins prenatally with the emergence of the auditory system. Already before birth, but also afterward, infants preferentially respond to familiar speech sounds, specifically, to sounds produced by their mother (DeCasper & Fifer, 1980). This is shortly followed by vowel and consonant babbling occurring over the first few months (Stoel-Gammon, 1989; Haubrich, 1998). First words typically appear at around the first twelve to eighteen months of life, and at the end of this first stage, the child would typically have a productive vocabulary of about fifty utterances, most of which are meaningful (Stoel-Gammon, 1989). By their second birthday, most children

would have experienced a sudden spurt in vocabulary growth, obtaining a vocabulary of about fifty to a hundred words (Lenneberg, 1969). After which, children rapidly learn to combine words, starting with short, simple sentence-like phrases, later progressing to more complex sentences (Lenneberg, 1969).

However, not all children follow these language milestones perfectly. There exists substantial variation in the rate of language development among children, which is due to a combination of genetic and environmental factors. An influence of genetic factors is most evident in early childhood, where cumulative environmental influences are still low. Estimates of the heritability of language ability range from 1% to 82%, with the exact estimate depending on the age of the children analyzed, the method used to determine language ability, and the language outcome variable (Dale, Dionne, Eley, Plomin, 2000, Ganger, Pinker, Chawla, and Baker, 2002; Reznick, and Robinson, 1997; Stromswold, 2001). The effect of genetics on the variance of language development among children can be inferred from heritability research, language disorders, and sex differences.

With respect to sex differences, there is evidence that shows a female advantage for verbal learning. For example, some studies observe that girls acquire language at an earlier age than boys, producing their first words (Maccoby, 1966) and first sentences (Ramer, 1976) earlier than their male peers. Using the MacArthur-Bates Communicative Development Inventories (MCDI), researchers found significant sex differences for one and two year old children on both vocabulary comprehension and vocabulary production in favor of girls (Feldman, Dollaghan, Campbell, Kurs-Lasky, Janosky, & Paradise, 2000; Fenson,

Dale, Reznick, Bates, Thal, & Pethick, 1994). Lastly, it is more common for boys to be "language-delayed" than girls (Wulbert, Inglis, Kriegsmann, and Mills, 1975), and boys are at a greater risk of developing language disorders (McCarthy, 1953; Wallentin, 2009). Apart from sex differences in language, sex differences are also observed in the way infants interact with their mothers. In a study by Wasserman and Lewis (1985), it was observed that proximity seeking was higher in girls than boys, and was associated with increased touching when mothers were passive.

Notably, however, sex effects among normally developing children are very small, only accounting for one to two percent of the variance (Feldman, Dollaghan, Campbell, Kurs-Lasky, Janosky, & Paradise, 2000; Fenson et. al., 1994). Moreover, they typically disappear around the time children reach six years of age (Bornstein, Hahn, & Haynes, 2004).

Although genes contribute to the above effect (Olson, Wise, Conners, Rack & Fulker, 1989; Tomblin & Buckwalter, 1998), there is also plenty of evidence that points to environmental factors. These environmental factors include nutrition, socio-economic status (Paul, Spangel-Looney, and Dahm, 1991), exposure to language (Cusson, 2002; Mayberry, Lock, and Kazmi, 2002), and the opportunity for language use through mother-child play sessions (Holditch-Davis, Bartlett, and Belyea, 2000). Of these environmental factors, parental behavior plays a significant role in child language development (Phillips et al., 1987; Hoff, 2003; 2006). Because parents are an infant's first and primary form of social contact, they critically determine whether and how an infant

communicates (Crowell & Feldman, 1988; Pfeiffer & Aylward, 1990). Such communication can be fostered both through verbal and nonverbal behaviors, both of which will be examined below.

Verbal behaviors concern the way parents respond to their infant's vocalizations or bids to attention (Bornstein, Tamis-LeMonda, 1989). In several studies, verbal behaviors was operationalized as parental speech that semantically matches the children's speech, and this was found to predict children's achievement of language milestones (Furrow, Nelson, & Benedict, 1979; Tamis-LeMonda, Bornstein, and Baumwell, 2003). Additionally, researchers have explored the amount and linguistic sophistication of parental speech and its impact on language development. General findings from this work demonstrate that motherese, a mother's choice of simply constructed sentences, facilitated child language development (Furrow et. al., 1979; Fernald & Simon, 1984).

In addition to verbal interaction, parents also employ a rich repertoire of nonverbal expressions as part of the communicative process with their children. The nonverbal expression of particular interest here is parental touch. Friendly physical contact such as hugging, stroking or kissing of children has been implicated in the development of motor, cognitive and social functions that seem critical to speech and language.

The effects of touch on motor development have been examined in low birth weight infants. Ferber and Makhoul (2004) separated mothers into two groups, treatment and control, where infants in the treatment condition were held skin-to-skin by their mothers for an hour, while control group infants were

brought to the newborn nursery. Infants who were held exhibited more advanced gross motor movement as compared to the control (Ferber & Makhoul, 2004). In addition, a regression analysis performed by Weiss, Wilson, and Morrison (2004) demonstrated that maternal touch significantly contributed to six percent of the variance in infant gross motor movement.

The role of motor development for a child's language and speech may be inferred from an association between developmental speech and language disorders on the one hand, and motor problems on the other hand (Visscher, Houwen, Scherder, Moolenaar, and Hartman, 2007). In other words, infants who have motor problems also tend to have language disorders. Moreover, in order to produce comprehensible speech, it is critical to have fine motor control of the muscles of the vocal cords (Iverson, 2010). From studies by Visscher et. al. (2007), Weiss and colleagues (2004), and Ferber and Makhoul (2004), an indirect link between maternal touch and language development can be inferred; maternal touch is positively correlated with motor development, which in turn is positively correlated with language development.

Maternal touch also has a profound effect on an infant's cognitive development. Among others, evidence comes from a study by Weiss and colleagues (2004) who videotaped mothers breast or bottle feeding their infants at three months of age, and coded their tactile behavior during feeding using the Tactile Interaction Index (TII; Weiss, 1992). At one year of age, infants were tested using the Mullen Scales of Early Learning (MSEL; Mullen, 1995) in the areas gross motor movement, visual receptive organization, visual expressive and

fine motor organization, language comprehension, and language expression. Of the tested cognitive areas, language expression showed a significantly positive relationship with maternal touch.

Another approach in examining the link between touch and cognitive development has been to explore the effect of Kangaroo care. Kangaroo care is a technique practiced on a newborn, typically involving preterm infants, by which mothers hold their child in skin-to-skin contact. When compared to the control group, infants held in Kangaroo care as newborns showed increased IQ at 12 months as tested with the Griffith's IQ test (Griffiths, 1970). The IQ score derived from this test consists of combining subscale scores on locomotor, personal-social, hearing and speech, hand and eye coordination, performance, and practical reasoning (Tessier et al., 2003). The difference observed in IQ was the greatest among premature infants requiring intensive care, and having been diagnosed as neurologically abnormal at six months (Tessier et al, 2003). Together, this work demonstrates the potential benefits of parental touch for basic cognitive skills and IQ. Moreover, it provides a critical incentive for the present work as there is evidence showing that IQ and language are positively linked (Moore, 1968).

Apart from links to motor and cognitive development, research revealed a link of touch to social development (see review by Gallace & Spence, 2010). Foremost here is evidence that maternal touch aids the attachment process in children (Bowlby, 1958; 1977). Attachments form through experiences with caregivers and were originally classified into three broad categories of organized

attachment[1]: Secure, anxious-resistant insecure/ ambivalent, and anxious-avoidant insecure (Ainsworth & Bell, 1970). Secure attachment is characterized by an infant exploring freely in a strange situation with their caregiver present, is visibly upset when the caregiver departs, but is happy on their return. Securely attached children typically engage with strangers in the presence of their caregiver, returning for emotional support from time to time during the period of exploration. Children who have anxious-resistant/ambivalent attachment often showed distress on separation, were difficult to soothe on the caregiver's return, but responded in a passive or resentful manner in response to the caregiver's absence. Anxious-avoidant-insecure attachment is characterized by little emotional range, where the infant does not show distress on separation, and either ignored the caregiver on their return, or approached the caregiver with ambivalence. Secure attachments are more strongly associated with affectionate touch than are insecure or avoidant attachments (Ainsworth, 1979; Egeland & Farber, 1984; Grossman, Grossman, Spangler, Suess & Unzner, 1985; Ainsfield, Casper, Nozyce & Cunningham, 1990; Weiss, Wilson, Hertenstein & Campos, 2000), suggesting that touch facilitates bonding and perhaps emergent social skills that are necessary for the creation of social ties.

Work from our lab explored this latter possibility. Specifically, Reece and Schirmer (under review) observed mothers playing with their children, and coded

---

[1] A fourth classification, disorganized / disoriented attachment, was later added by Ainsworth's colleague Mary Main (Main & Solomon, 1990) in order to address other observed infant behaviors that did not fall in line with the original three classifications of attachment. If the infant does not appear to achieve either proximity or relative proximity with the caregiver, its behavior is considered "disorganized" as it indicates a disruption in the attachment system by fear. An infant characterized by disorganized attachment seems confused or apprehensive in the presence of the caregiver, demonstrating a mix of behaviors including resistance and/or avoidance.

how frequently the mothers touched them. Subsequently, they subjected the children to an object categorization task with faces and houses as background distracters. They found that instrumental touch, defined as touch purposefully directed at the child, predicted performance differences between the condition with face and that with house distracters. Compared to children who received less instrumental touch, children who received more instrumental touch were more distracted by faces relative to houses. A similar effect for incidental touch, defined as touch directed away from the child and only accidentally involving the child, was non-significant. These results concur with evidence from non-human animals, which found a causal link between the amount of touch an offspring received, changes in the brain's oxytocin system, and the offspring's propensity to care for its own young later in life (Meaney, 2001; Champagne & Meaney, 2007; Champagne, 2008). Together, this work highlights the possibility that touch shapes social development by making social stimuli more interesting or relevant.

Apart from faces, speech could be another stimulus which may have a direct link between touch and language development. Alternatively, the link may be indirect through a heightened engagement in socio-emotional processing that has increased verbal communication as a consequence. For example, by bonding with and seeking out others, children expose themselves to more language in social situations. In line with this is research on joint attention, a phenomenon during which two individuals focus on the same object because one individual's eye-gaze informs and guides the other's eye gaze (Dunham & Moore, 1995). As expected, the ability to engage in joint attention in infancy predicts language

ability in young children (Tomasello, 1988; Baldwin, 1995; Mundy & Gomes, 1998; Charman, Baron-Cohen, Swettenham, Baird, Cox, and Drew, 2000; Brooks & Meltzoff, 2005).

There is an abundance of research that outlines a relationship with parental touch on the one hand, and motor, cognitive and social development on the other hand. Although findings from this research insinuate that maternal touch could have an influence on language development, this implication is indirect and rests on the relationship between motor, cognitive and social skills to language. At present, direct evidence between maternal touch and child language development is extremely scarce. Kelmanson & Adulas (2009) assigned a group of low birth weight infants at two months of age to massage intervention therapy that included rubbing, stroking, and other kinaesthetic stimulation performed by researchers who were trained on massage techniques. Infants in the control group were simply left to follow their usual routine. Massage therapy was performed until the infants reached the age of eight months, and these infants were required to return for monthly follow-up visits. During each visit, the Infant Development Inventory was used to check each infant's neuro-motor skills, including social, self-help, gross motor movement, fine motor movement, and language skills. At four months of age, the infants in the treatment group laughed more, turned their heads more frequently towards voices, and, by seven months of age, were more likely to respond to their names by turning their heads and looking at the speaker (Kelmanson & Adulas, 2009). The results obtained from this study are important because it demonstrates a link between touch and vocalization. As speech and

language development emerges from vocalizations (Papoušek & Papoušek, 1991), and early vocalizing predicts word acquisition (Lyytinen, Poikkeus, Leiwo, Ahonen, and Lyytinen, 1996), these findings by Kelmanson and Adulus (2009) imply that touch could give children a linguistic head start.

In sum, existing research raises the possibility that parental touch contributes to the variance observed in language development among children. However, direct evidence between maternal touch and language development is is at present limited to one study (Kelmanson & Adulas, 2009). The present work was conducted to address this limitation and to answer the following two questions. The first question was whether the frequency of maternal touch positively correlates with children's language competency, and as such, can account for inter-individual differences such as that observed between boys and girls.

Second, it was of interest to find out what particular touch actions are of most importance in terms of accounting for the variance observed in child language development. According to research by Reece and Schirmer (under review), it was hypothesized that instrumental touch should be a more relevant predictor of child language variables than incidental touch. This was based on their results that showed a relationship between instrumental touch and social processing that was absent for incidental touch. Based on their results, Reece and Schirmer speculated that during lab-based mother-child interactions, instrumental touch may be more indicative of the frequency with which children are touched in the home environment.

In addition to dissociating instrumental from incidental touch, the current thesis project aimed at taking a closer look at different kinds of instrumental touch. According to research in non-human animals and humans, stroking is an action of particular relevance because it preferentially activates C-tactile afferents that presumably convey specifically social touch (Loken, Wessberg, Morrison, McGlone, & Olaussen, 2009). In non-human animals, stroking has been shown to shape brain development (Guzzetta et. al., 2009). In humans, it was found to evoke particularly pleasant sensations (Loken et. al., 2009) that can be processed unconsciously (Fisher, Rytting, Heslin, 1976; Gueguen, 2002) and relate to a heightened interest in faces (Wijaya & Schirmer, in preparation; Reece & Schirmer, under review). Thus, there is a possibility that stroking and brushing touch actions may have a greater association with language development than other touch behaviors like leaning or bumping.

The two research questions posed here were addressed using a design similar to that of Reece and Schirmer (under review). Mothers and their children aged 2 and 5 were instructed to play with some toys together in the same way that they would play at home. These age groups were selected because examining the cross-sectional development of 2 and 5 year olds should provide a good overview of early language development. Children at age 2 would have just started speaking in two to three word sentences, whereas children at 5 would have a well established grasp of language and be able to produce complex speech (Lenneberg, 1969). The play sessions were first recorded on video, then later coded for maternal touch as well as maternal speech, which was used as a control behavior.

The control maternal behavior was critical to determine whether any potential effects of touch were specific to touch or result from more general aspects of maternal responsiveness. The children's language skills were estimated based on a speech analysis from the play session.

Based on the literature reviewed above, the following predictions were made. First, age and sex differences with respect to the maternal behaviors and the child language measures were expected. In line with what is known, older children should receive less touch (Ferber, Feldman, & Makhoul, 2008; Jean, Stack & Fogel, 2009), and should be spoken to in more complex language as compared to younger children (Fraser & Roberts, 1975). Also, the language of older children should be more complex than that of younger children. In addition, it was expected that mothers would speak more to girls than boys (Wasserman & Lewis, 1985), and for girls to receive more touch than boys (Sears, Macoby, & Levin, 1957). Furthermore, girls were expected to speak more than the boys (Newman, Groom, Handelman & Pennebaker, 2008), and their language competence was expected to be more advanced in terms of complexity (Maccoby & Jacklin, 1974; Kramer, Delis, Daniel, 1988).

Second, and more importantly for the present purpose, maternal touch was hypothesized to be positively correlated with the child language measures, specifically for instrumental and stroking touches. Moreover, if touch has a special role for language development, its correlation with child speech may be stronger than the correlation of an alternative maternal behavior, maternal speech, with child speech.

2. Method

The data acquisition for this study was part of a larger longitudinal project conducted by researchers at the Max Planck Institute for Human Cognitive and Brain Sciences (Leipzig, Germany). This project was aimed at exploring a number of predictors for child language development including the two predictors (maternal touch, maternal speech) that were of interest for this thesis. My contribution to this research was the development of the research questions as outlined above, and performing the data analysis necessary in order to answer these questions.

2.1 Participants

One hundred and forty-five mothers and their 2 to 5 year old children were contacted and screened for participation in the study. Participants were identified from an existing participant database or through advertisements in kindergartens and the local newspaper. Prior to participating in this study, all parents completed a questionnaire on their child's development that was used to determine child inclusion. Children who were previously diagnosed as developmentally delayed, who were prematurely born, or who spoke languages other than German were not allowed to participate in the study (N = 14).

One hundred and thirty-one children passed the initial screening and were recruited to participate in this study. From these, sixteen were excluded from data analysis due to non-compliance (N=4), a father accompanying the child (N= 5), a sibling being present (N=1), the child having significant language deficits (N=2), the child being too old (N=1), an absence of written language data (N=1), and the

loss of one of the two videos recorded during this study (N=2). The final sample thus consisted of a total of one hundred and fifteen mother-child dyads. Children were 2 years old in 60 dyads (30 girls, 30 boys, mean age = 2.05 years, *SD* = 0.033), and 5 years old in 55 dyads (25 girls, 30 boys, mean age = 5.06 years, *SD* = 0.033).

Parents were compensated for their time with €7.50, while children received a small gift as a token of appreciation at the end of the study.

2.2 Procedures and Measures

Sessions took place in an experimental room containing a couch, a table (80x80 cm), a cupboard, and a small sink. Daylight from the window was blocked with blinds, and ceiling lights were switched on to ensure consistent lighting conditions across participants.

Each session consisted of five components: (i) a warm-up game to acclimate the parent and child to the testing environment, (ii) a mother-child play session, (iii) a mother-child book reading session, and (iv) a language test for the children. The order of playing and book reading was counterbalanced across participants. In this report, only the play session was analyzed.

Two AXIS Q1755 HD Network Cameras, controlled from the outside of the room, were used to videotape the sessions. One was attached to a tripod and faced the dyad from the front, while the other was mounted on the ceiling above the couch where the participants were positioned. The distance between cameras and couch was 3.88 m for the front camera, and 1.75 m for the ceiling camera.

2.2.1 *Warm-Up Task*

This initial task lasted about five minutes. The 2-year olds were given a puzzle, whereas the 5-year olds were given a card game to play with their mother. This task was used with the intention of helping the dyad acclimate to the testing environment. It was not analyzed.

2.2.2 *Play and Book Session*

Mothers were told to make use of the whole ten-minute period to engage in playing (play session) or reading (book session) with their children in the same way as they would at home without leaving the area surrounding the couch and table.

Children were allowed to stand up if they preferred that to sitting, and could move to either the left or right of the table. If the child did not cooperate such that sessions were shorter than six minutes, the sessions were not analyzed. Children were considered non-cooperative if they did not like the book, refused to play, or refused to speak at all. Session timings ranged from 7 minutes 42 seconds to 13 minutes 48 seconds (mean session length = 10 min 21 seconds, *SD* = 0.45).

Children were also allowed to leave to go to the bathroom for a break before returning to the experiment (N= 1). After giving instructions, the experimenter left the room. To mark the exact beginning of book and play sessions in the video, the room lights were shortly switched off and switched back on. The target duration for botch sessions was 10 minutes, and the end of each session was marked by the entrance of the experimenter to switch off the camera.

2.2.2.1 *Play Session*

This session was supposed to last ten minutes and was unstructured. The 2-year olds played with DUPLO while the 5-year olds were given PLAYMOBIL toys. Toys were presented in a colorful picnic basket, and placed in front of the mother and the child. After giving instructions, the researcher left the room for the duration of the play session.

Figure 1. Experimental setup for the play session is illustrated here. The book session set-up was identical to this.

2.2.2.2 *Book Session*

In this 10-minute session, parents were told to read with their child. The 2-year olds received *Schau mal an, was Paulchen kann!*, whereas the 5-year olds received *Lukas und der Wunschkäfer*. The text from both books was removed. After giving instructions, the researcher left the room for the duration of the book session. This session was not analyzed.

2.2.3 *Grammar Questionnaire*

Parents were given a questionnaire to complete on behalf of the 2-year olds at home. The questionnaire was a modified version of *Fragebogen zur*

frühkindlichen Sprachentwicklung (FRAKIS)[2]. This questionnaire assessed the child's vocabulary and grammar. Data from the FRAKIS was not included in this thesis.

2.2.4 *Post-Task Grammar Test*

All children completed the *Test zum Satzverstehen von Kindern* (TSVK). The TSVK is a picture selection task that summarizes variables related to the understanding of syntactic information related to transitivity, tense, argument structure, pronouns and voice. The 2-year olds completed Subtest 1 of the long version of the TSVK, which only contained items on transitivity. The 5-year olds completed the short version of the TSVK, which contained items on all the syntactic phenomena described above. Data from this questionnaire was not included in this thesis

2.3 Data Analysis

The coding of maternal and child vocalization was performed by a group of trained interns led by doctoral candidate, Tanja Poulain from the Max Planck Institute. This group first transcribed all videos and then coded for utterance length, a standard measure in studying speech complexity (Nienhyus, Cross, and Horsborough, 1984) and an indicator of the child's syntactic ability. Additionally, speech frequency was coded as an indicator for the comfort with and readiness to engage in verbal exchanges. An utterance was determined based on the speaker's intonation and pauses, where an utterance usually corresponded to a sentence.

---

[2] Szagun, G., Stumper, B. & Schramm, A.S. (2009). Fragebogen zur frühkindlichen Sprachentwicklung (FRAKIS) und FRAKIS-K (Kurzform) (Questionnaire on early language development (FRAKIS) and short form (FRAKIS-K). Frankfurt: Pearson Assessment.

Speech frequency refers to the number of utterances produced per minute. All videos were transcribed by two independent researchers, with Tanja always being one of them. She also coded all of the videos, one-fifth of which were independently coded a second time by an intern. ELAN ("ELAN v 4.6.1", 2013) was used for transcription, and agreement was very high between the coders for the video transcripts. Excel was used to calculate speech frequency, while utterance length for both mother and child was calculated with CLAN (CLAN; 2013- "The CHILDES Project").

As this study was meant to be a follow-up of Reece and Schirmer (under review) on maternal touch and child face sensitivity, the same touch coding system was used for this study. Specifically, Reece and Schirmer (under review) developed a coding system for maternal touch behavior that incorporated several published coding systems (Feldman, Weller, Sirota, & Eidelman, 2003; Ferber, Feldman, & Makhoul, 2008; Franco, Fogel, Messinger, & Frazier, 1996; Grossmann, Thane, & Grossmann, 1981; Herrera, Reissland, & Shepherd, 2004; Jung & Fouts, 2011; Moreno, Posada, & Goldyn, 2006; Polan & Ward, 1994; Weiss, 1992). Dyadic touches were classified according to touch intent and touch action. For touch intent, any observed touch was either coded as incidental or instrumental touch. Incidental touch results from close proximity, as opposed to a deliberate action (Feldman et al., 2003; Herrera et al., 2004; Jung & Fouts, 2011; Polan & Ward, 1994). Instrumental touch refers to touches that are directed towards the recipient, like trying to redirect the child's attention by means of touching the child's arm (Grossmann et al., 1981; Jung & Fouts, 2011; Moreno et

al., 2006). Touches irrespective of intent were further coded into touch subtypes. These subtypes were stroking, brushing, holding, pushing, and pulling touches (Reece & Schirmer, 2013).

Additionally, this study examined instrumental touch based on maternal intention as in when the mother was fixing or cleaning the child, performing supportive actions, inhibiting the child from performing a particular action, or making an affectionate gesture (Feldman et al., 2003, Ferber et. al., 2008, Franco et. al., 1996, Jung & Fouts, 2011, as cited by Reece & Schirmer, 2013). The descriptions of all touch actions are listed in Table 1 of the results section.

The coding of maternal touch behavior was performed by the author of this thesis, and a team of research assistants (RAs) from the National University of Singapore. RA Stella Guldner coded several video recordings from the play session, and trained the author along with seven other research assistants. The author trained the next batch of five research assistants on this project in the same manner. The video recording made for each dyad with the two cameras was coded for touch by two coders. Coding was done simultaneously for the two camera positions as they were synchronized using the ELAN software ("ELAN v 4.6.1", 2013).

Despite training, the inter-rater reliability for touch coding between any pair of research assistants was initially poor. It was not uncommon for one RA of a pair to miss a tactile instance that was noted by the other, and vice versa. In order to address the issue, the author of this thesis compared video time stamps for tactile instances and marked discrepancies. The RAs then independently re-

checked the videos for the time stamps that had been flagged in order to determine if they had missed or wrongly recorded a tactile incident. They were not given any information about what kind of touch was discrepant or missed. The coding guidelines for touch are provided in Appendix A.

3. Results

3.1 Preliminary Analysis

3.1.1 *Maternal and Child Behavior Coding*

Speech frequency and utterance length are unambiguous measures such that they could be coded by only one individual without concerns about reliability. This was different for touch. Thus, touch was coded by two individuals and the touch coding reliability was calculated using two-way consistency intra-class correlations (ICC) (McGraw & Wong, 1996; Shrout & Fless, 1979). The resulting ICC was 0.883 for incidental touch and 0.864 for instrumental touch. The ICCs for the individual touch actions (e.g., stroking, holding) are presented in Table 1, they ranged from 0.623 to 0.883.

Krippendorff (1980) provides a guideline for interpreting ICC values, suggesting that conclusions should be discounted for variables with values less than 0.67, for conclusions to tentatively be made for values between 0.67 and 0.80, and for definite conclusions to be made for values above 0.80. Given these criteria, the present analysis focused on the broader categories of instrumental and incidental touch. Moreover, sub-categories of touch were examined only for ICCs greater than 0.67. Unfortunately, the ICC for stroking, a touch action of particular interest here, was only 0.526 and thus unsuitable for analysis.

Table 1. Descriptions of Maternal Touch Types and Intraclass correlations (ICC) of Maternal Touch and Subcategories. Two way consistency scores are reported.

Maternal Touch Category	**Description**	**2- way ICC**
Incidental	Touch that occurs by way of actions directed at another purpose other than the touch itself.	0.883
Instrumental	Touch that is performed deliberately.	0.864
Stroking	Hand moving against the surface of another body part.	0.526
Brushing	Two body parts moving against each other.	0.210
Holding	Grasping of hand; including pinches.	0.832
Pushing	Movement involving direction away from self; includes nudges, tickles, or pokes.	0.786
Pulling	Movement involving direction towards self; includes carrying the child toward self.	0.623
Fixing	Adjusting position of the child, child's clothing, or cleaning the child.	0.790
Supporting	Appearing to help the child.	0.646
Inhibiting	Actively changing or stopping the action of the other, not for the purpose of help.	0.819
Affection	Intentional touch that gives an impression of closeness between mother and child.	0.766

3.1.2. *Sample Distribution of Maternal Behaviors*

In a preliminary analysis, the group distributions of all maternal and child behaviors were explored. Participants (N =1) with scores +/- 3SD away from the mean were excluded from analysis. After which, the distributions were checked for normality. All maternal and child speech measures were observed to be normally distributed based on Shapiro's test, but none of the two maternal touch

measures were normally distributed. Thus, whenever possible, non-parametric tests were used to analyze the touch results. Only for analyses with multiple factors was the ANOVA approach used for lack of a better alternative, and also because current evidence suggests that it is fairly robust in case of non-normality (Schmider, Ziegler, Danay, Beyer & Bühner, 2010; Weerahandi, 1995).

The distributions of mother and child speech behaviors are illustrated as boxplots in Figure 2, while the distributions of maternal touch are illustrated in Figure 3.

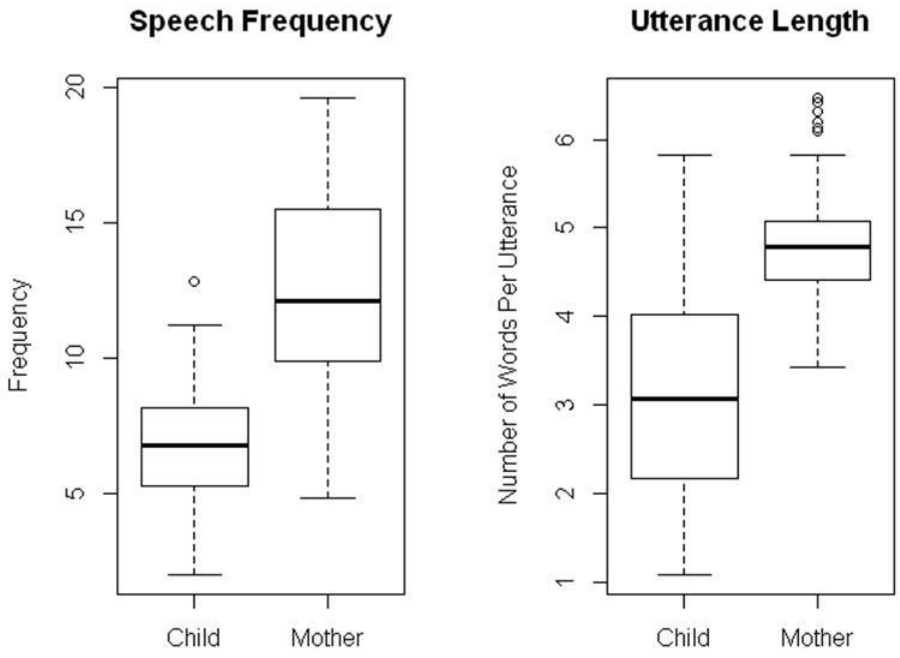

Figure 2. Distributions of maternal and child speech behavior frequencies. Error bars reflect 95% confidence intervals.

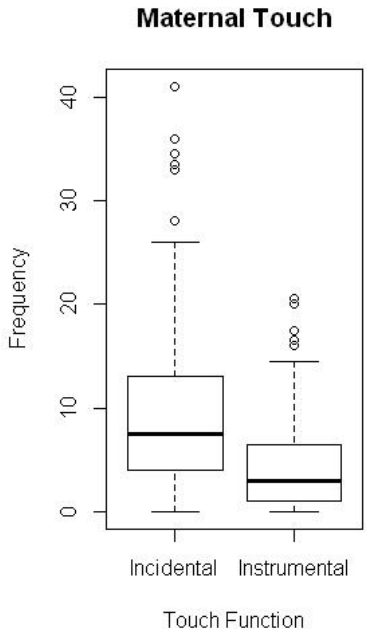

Figure 3. Maternal touch distributions by Touch Function.
Error bars reflect 95% confidence intervals.

3.2 Analysis of Maternal Behaviors

3.2.1 *Frequency of Maternal Touches of Different Function*

The frequency of maternal touch was subject to a four-way mixed ANOVA, with Touch Function (incidental / instrumental) as a within subjects factor, and Sex (male / female), Age Group (2 years / 5 years) and Observational Order (Play session first / Play session second) as between subjects factors.

This yielded a significant main effect of Touch Function ($F(1, 106) = 44.0$, $p < 0.001$). This main effect was further qualified by an interaction between Age Group and Touch Function ($F(1,106) = 7.23$, $p < 0.001$). Follow-up analysis of the interaction with the Mann–Whitney–U test indicated that 2 year-olds received significantly more instrumental touch than did 5 year olds ($U = 2469.5$, $p < 0.001$), but there was no difference in the amount of incidental touch received

between 2 year-olds and 5 year-olds (U = 1697.5, p > 0.1). Figure 4 depicts the frequency distribution of maternal touch behaviors for 2 year-olds and 5 year-olds by Touch Function.

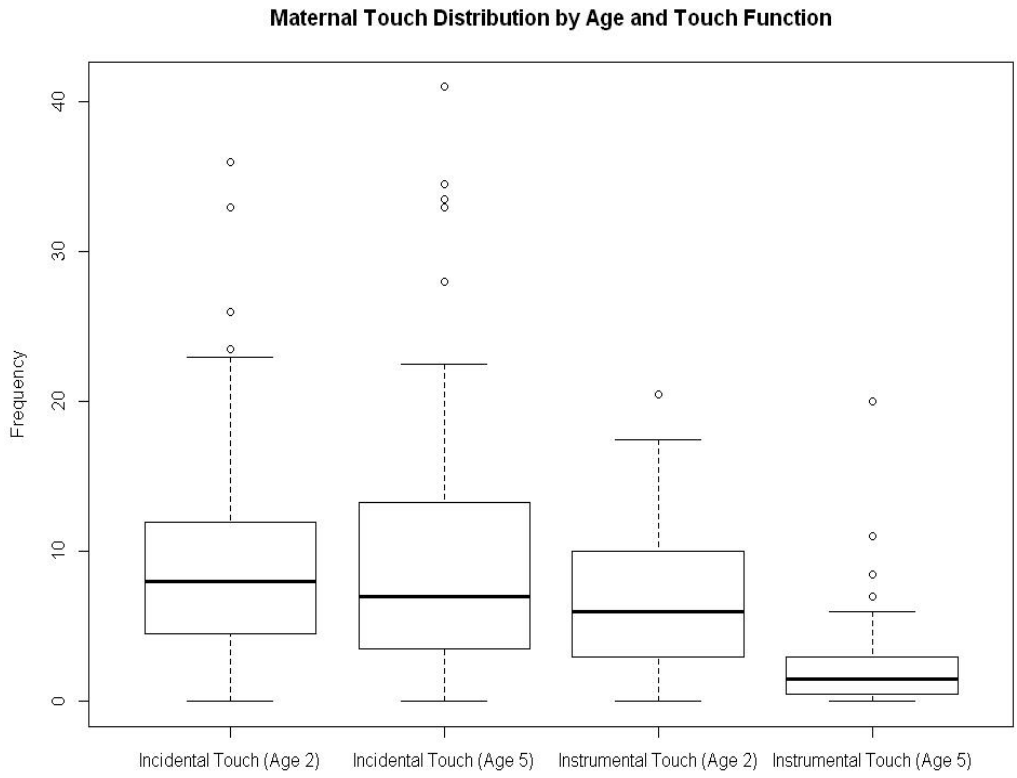

Figure 4. Maternal touch distribution split by Age Group and Touch Function. Error bars reflect 95% confidence intervals.

3.2.2. *Analysis of Maternal Speech*

Maternal speech frequency (utterances per minute) was subject to a three-way ANOVA with Sex (male / female), Age Group (2 years / 5 years) and Observation Order (Play session first / Play session second) as between subjects factors. This yielded a main effect of Age Group (F(1,106) = 18.7, p < 0.001) indicating that mothers of 2 year olds (M = 13.6, SD = 3.32) spoke more than

mothers of 5 year olds (M = 11.2, SD = 3.02). These results are illustrated in Figure 5.

No further main effects and interactions were significant (all ps> 0.1).

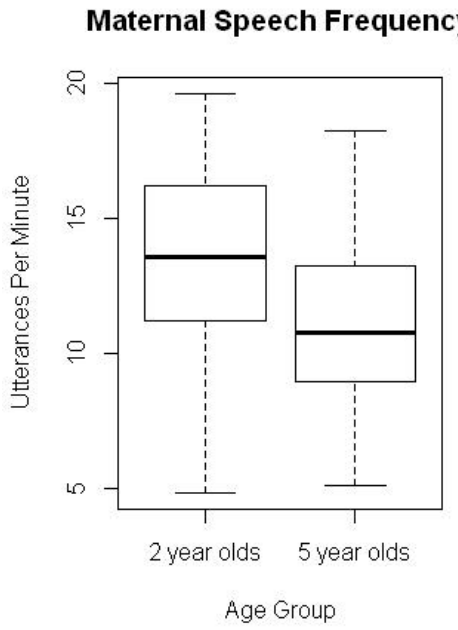

Figure 5. Maternal speech frequency distribution split by Age Group. Error bars reflect 95% confidence intervals.

Analysis of maternal utterance length revealed a main effect of Age Group (F(1,106) = 26.8, p < 0.001), where mothers of 2 year old children (M = 4.53, SD = 0.535) made shorter utterances as compared to mothers of 5 year olds (M = 5.05, SD = 0.551). In addition, there was an interaction between Sex and Observation Order (F(1,106) = 4.36, p < 0.05). These results are illustrated in Figure 6.

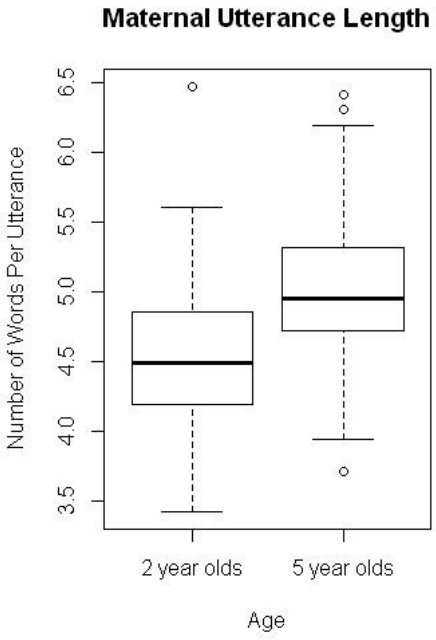

Figure 6. Maternal utterance length split by Age Group. Error bars reflect 95% confidence intervals.

Follow-up of the interaction of Sex and Observation Order using Welch's t-test demonstrated that Observation Order made a significant difference for boys, ($t(55)= -2.36$, $p < 0.05$). Mothers spoke longer utterances to boys when they went for the play condition after the book condition ($M = 4.98$, $SD = 0.583$), as opposed to undergoing the play condition first ($M = 4.64$, $SD = 0.495$). However, there was no significant difference ($t(50)= 0.528$, $p > 0.1$) in maternal utterance length for the girls between undergoing the play session first ($M = 4.80$, $SD = 0.734$) and second ($M = 4.70$, $SD = 0.556$). These results are illustrated in Figure 7.

No further main effects and interactions were significant (all ps> 0.1).

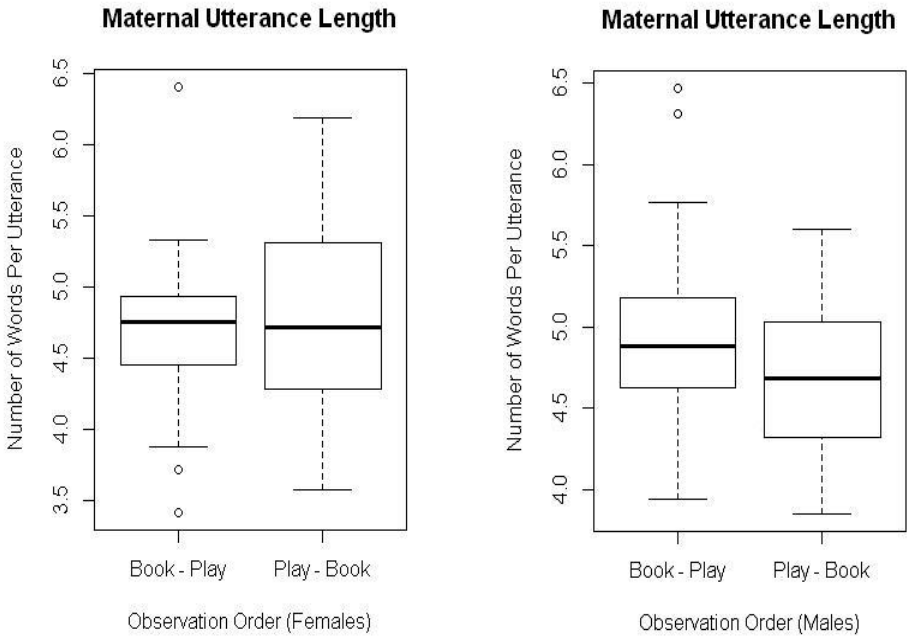

Figure 7. Maternal utterance length split by Sex and Observation Order. Error bars reflect 95% confidence intervals.

3.3 Analysis of Child Speech

Child speech frequency was subjected to a three-way ANOVA with Sex (male / female), Age Group (2 years / 5 years) and Observational Order (Play session first / Play session second) as between subjects factors.

This yielded a significant main effect of Observation Order ($F(1, 106) = 5.26$, $p < 0.05$), that was qualified by an interaction with Age Group ($F(1, 106) = 5.39$, $p < 0.05$). Follow-up analysis of this interaction with Welch's t-tests found that 2 year olds spoke significantly more ($t(55) = 3.55$, $p < 0.001$) when the play session came first ($M = 7.77$, $SD = 2.09$), as compared to when the play session came second ($M = 6.03$, $SD = 1.66$). There was no significant difference ($t(53) = -6e\text{-}04$, $p > 0.1$) on the amount that 5 year olds spoke when the play session came first ($M = 7.13$, $SD = 1.97$) as compared to when it was conducted second ($M = 7.13$, $SD = 2.18$). This effect is illustrated in Figure 8.

No further main effects and interactions were significant (all ps> 0.1).

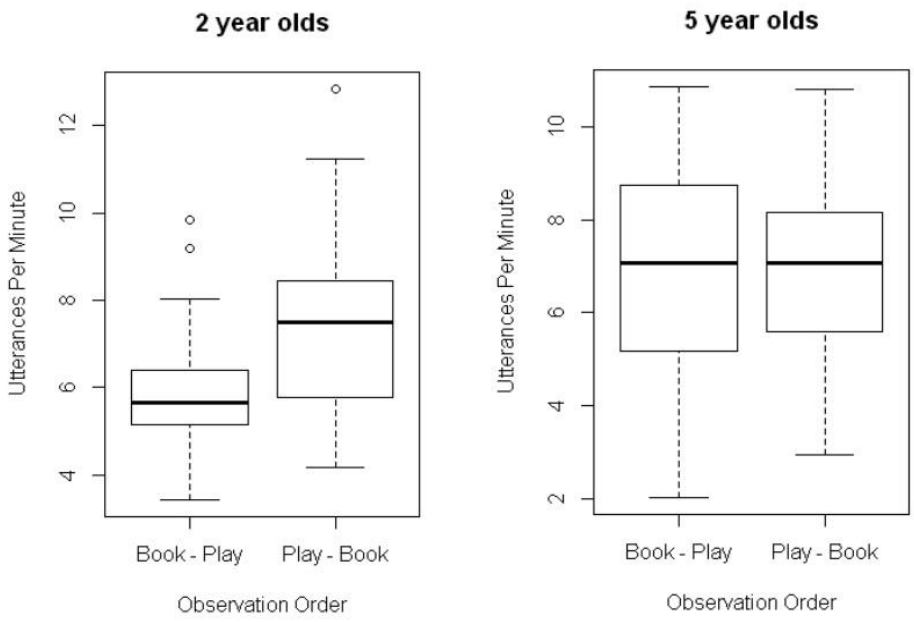

Figure 8. Child speech frequency distribution split by Age Group and Observation Order. Error bars reflect 95% confidence intervals.

Analysis of the children's utterance length produced a main effect of Age Group ($F(1,106) = 190$, $p < 0.001$), where 5 year olds ($M = 4.03$, $SD = 0.717$) made longer utterances than 2 year olds ($M = 2.22$, $SD = 0.697$). This effect is illustrated in Figure 9.

No further main effects and interactions were significant in the analysis of child utterance length (all ps > 0.1).

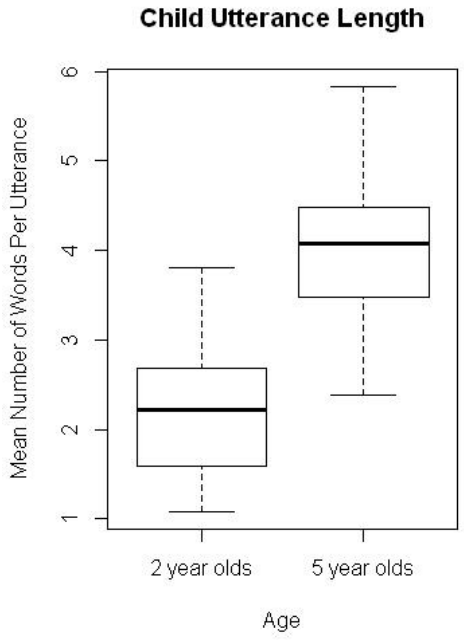

Figure 9. Child utterance length split by Age Group.
Error bars reflect 95% confidence intervals.

3.4 Relationship Among Maternal Behaviors

The relationships between the different maternal behaviors were analyzed separately for each age group using a series of Spearman correlation tests. Based on the effects of Observation Order and Sex of the child as reported above, both of these variables were partialled out. The complete set of results is presented in Tables 2 and 3.

For mothers of 2 year old children, there was a significant positive relationship between instrumental maternal touch and maternal speech frequency, ($r_s = 0.286$, $p < 0.05$).

For mothers of 5 year old children, there were significant positive correlations between incidental and instrumental maternal touch ($r_s = 0.305$, $p <$

0.05) and between incidental maternal touch and maternal utterance length (r_s = 0.330, $p < 0.05$).

Table 2. Relationship Among Maternal Behaviors for Mothers of 2 Year Old Children

2 year olds	Instrumental Maternal Touch	Incidental Maternal Touch	Maternal Speech Frequency	Maternal Utterance Length
Instrumental Maternal Touch	--	-0.179	0.286*	0.154
Incidental Maternal Touch	--	--	0.185	-0.016
Maternal Speech Frequency	--	--	--	0.083

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

Table 3. Relationship Among Maternal Behaviors for Mothers of 5 Year Old Children

5 year olds	Instrumental Maternal Touch	Incidental Maternal Touch	Maternal Speech Frequency	Maternal Utterance Length
Instrumental Maternal Touch	--	0.305*	-0.098	-0.031
Incidental Maternal Touch	--	--	0.036	0.330*
Maternal Speech Frequency	--	--	--	0.065

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

3.5 Relationship Between Maternal Touch and Child Speech

The relationships between instrumental and incidental maternal touch and each of the child speech behaviors were probed using Spearman partial correlations.

The data were analyzed separately by Age Group, where Observation Order, Sex, maternal speech frequency, and maternal utterance length were partialled out. There were no effects for the 2 year olds or the 5 year olds for either instrumental maternal touch or incidental maternal touch.

As we were also interested in disentangling the differential effects of instrumental touch on child speech, the relationships between instrumental touch actions that had ICC correlations greater than 0.67 and each of the child speech behaviors was examined using Spearman correlations partialling out the same variables as listed above. This revealed a significant negative effect for holding in 2 year olds (r_s = -0.317, $p < 0.05$) and a marginal negative effect for pushing in 5 year olds (r_s = -0.267, $p = 0.058$).

Results are presented in Table 4a and 5a for instrumental and incidental maternal touch, respectively. Results for the various significant instrumental touch actions are presented in Table 4b and 5b.

Table 4a. *Relationship Between Instrumental Maternal Touch and Child Speech*

	Child Speech Frequency	Child Utterance Length
2 year olds: Instrumental Maternal Touch	-0.061	-0.151
5 year olds: Instrumental Maternal Touch	-0.226	-0.132

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

Table 4b. *Relationship Between Instrumental Maternal Touch Subtypes and Child Speech*

	Child Speech Frequency	Child Utterance Length
2 year olds:		
Holding	-0.002	-0.317*
Pushing	-0.171	-0.034
Fixing	0.046	0.064
Inhibiting	0.082	-0.217
Affection	0.008	-0.090
5 year olds:		
Holding	-0.078	0.059
Pushing	-0.003	-0.267^
Fixing	0.242	-0.198
Inhibiting	-0.199	0.110
Affection	-0.008	-0.158

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

Table 5a. Relationship Between Incidental Maternal Touch and Child Speech

	Child Speech Frequency	Child Length Utterance
2 year olds: Incidental Maternal Touch	-0.063	0.091
5 year olds: Incidental Maternal Touch	-0.222	-0.091

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

Table 5b. Relationship Between Incidental Maternal Touch Subtypes and Child Speech

	Child Speech Frequency	Child Utterance Length
2 year olds:		
Holding	-0.125	0.089
Pushing	-0.072	-0.239
Fixing	Not applicable	Not applicable
Inhibiting	Not applicable	Not applicable
Affection	Not applicable	Not applicable
5 year olds:		
Holding	-0.030	0.020
Pushing	-0.144	0.031
Fixing	Not applicable	Not applicable
Inhibiting	Not applicable	Not applicable
Affection	Not applicable	Not applicable

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

3.6 Relationship Between Maternal Speech and Child Speech

In addition to examining the relationship among maternal touch and child speech behaviors, this study also sought to probe any possible relationships between maternal speech and child speech behaviors. These relationships were

examined using a Pearson correlation test because the speech data were normally distributed. Based on the effects of Observation Order and Sex of the child, these variables were partialled out of the analysis. In addition, instrumental and incidental touch were also partialled out.

Maternal speech frequency was negatively correlated with child utterance length in 2 year olds (r = -0.346, $p < 0.05$). There was also a marginal negative correlation between maternal speech frequency and child utterance length in 5 year olds, (r = -0.255, p = 0.07).

There was a positive correlation between maternal utterance length and child utterance length for the 2 year olds, (r = 0.390, $p < 0.05$).

Tables 6 and 7 exhibit the complete list of correlations between maternal behaviors for 2 year old children and 5 year old children respectively.

All other effects were non-significant (all ps> 0.1).

Table 6. *Relationship Among Maternal and Child Speech Behaviors in 2 Year Old Children*

2 year olds	Child Speech Frequency	Child Utterance Length
Maternal Speech Frequency	-0.161	-0.346**
Maternal Utterance Length	0.079	0.390*

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

Table 7. *Relationship Among Maternal and Child Speech Behaviors in 5 Year Old Children*

5 year olds	Child Speech Frequency	Child Utterance Length
Maternal Speech Frequency	0.068	-0.255^
Maternal Utterance Length	-0.104	0.156

*^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001*

3.7 Post-Hoc Analysis of the Relationship Between Maternal Touch and Child Touch

In order to fully understand how maternal touch relates to child touch, a post-hoc analysis of the present data was performed. A Spearman correlation between maternal and child touch partialling out Sex, Observational Order, maternal speech frequency, and maternal mean utterance length was not significant ($r_s = 0.155$, $p = 0.104$). .

Further examination for each age group revealed a significant relationship between maternal and child touch for the 5 year olds ($r_s = 0.299$, $p < 0.05$), but not for the 2 year olds ($r_s = 0.014$, $p < 0.1$). Moreover, in 5 year olds, the effect was driven by instrumental touch specifically ($r_s = 0.499$, $p < 0.001$; see Table 8).

Table 8. Relationship Between Maternal Touch and Child Touch

Age Group	Instrumental Touch	Incidental Touch
2 year olds	0.168	-0.080
5 year olds	0.499***	0.230

^p= 0.1-0.05; *p <0.05; ** p <0.01; *** p<0.001

4. Discussion

This study sought to document patterns of mother-child interactions and to relate these patterns to child speech development. We observed significant inter-individual variation for the maternal variables of interest, as well as significant inter-individual variation for the quantity and quality of child speech. The inter-individual variation of the quality and quantity of child speech was significantly related to the variation in maternal behavior. However, before detailing this relationship, the results obtained from each of the measured variables will be examined separately, and linked to the extant literature.

4.1 Child Speech

The present results suggest that 2 year olds, but not 5 year olds, tended to speak more when going through the play session before as compared to after the book session. This effect may be due to younger children having been more easily fatigued than older children by the book session.

There were age differences observed in the average length of utterances among the children, where 2 year old children spoke shorter sentences than the 5 year olds. This age effect is in line with the literature on speech development, where children start out with two-word combinations before moving onto short phrases, and eventually, sentences (Lenneberg, 1969).

Contrary to our predictions, there were no sex differences in language ability; girls did not perform significantly better than boys in this study. However, there has been a great deal of inconsistency in the literature on sex differences in language ability. While early studies demonstrated a female advantage in

language, subsequent studies revealed that sex differences were either not consistent, or small in magnitude (Hyde, 1981; Hyde & Lynn, 1988; Leaper & Smith, 2004).

It is possible that the task being used to evaluate language competence in young children may affect whether there is an observable sex effect. Behavioral studies suggest that tasks emphasizing associational aspects of verbal ability, such as verbal fluency (Maccoby & Jacklin, 1974; Leaper & Smith, 2004), consistently show large sex differences favoring females. In particular, a female advantage is most consistently observed in word fluency and vocabulary tests (Maccoby & Jacklin, 1974), and also in verbal memory tests that require organization or semantic manipulation of verbal information (Kramer, Delis, Daniel, 1988). Rather than measure verbal fluency in the form of vocabulary, our study measured language development based on the frequency of the child's utterances, as well as utterance length. Utterance length being more related to grammar as compared to vocabulary strength could be a possible reason for not finding a sex difference in language ability.

4.2 Maternal Touch

The frequency of maternal touch differed according to the child's age, but this effect was dependent on touch function. Two year old children experienced more instrumental touch than 5 year old children. However, since the physical proximity between mother and child were comparable between children of both age groups, the frequency of incidental touch received by both groups was comparable.

The effect for instrumental touch may reflect that mothers of younger children make use of touch in a more purposeful manner in order to regulate their child's behavior and emotion. In line with this, there is evidence that 3 year old children have difficulty with tasks that require inhibitory control of attention and motor responses, such as suppressing a dominant response in accordance with rules. By 5 years of age, they are much more proficient at these tasks (Carlson, 2005). At the same time, children improve in their ability to regulate the experience of emotions by monitoring their own expressive behavior. When young children made an attempt to inhibit negative expressions upon receiving an undesirable gift, they had trouble neutralizing their expressions. However, older children were generally more likely to attempt to feign positive expressions of emotion (Saarni, 1984). These findings demonstrate that younger children have greater difficulty with behavior and emotion regulation as compared to older children. Moreover, together with the present findings, the results found in the study by Saarni (1984) suggest that maternal touch serves the function of helping the child regulate their own emotions.

There is a small literature suggesting that the amount of parental touch received by boys and girls differs. Sex differences in both initiating and receiving touch emerge from a very early age in children. Within the first few months of life, male infants receive more touch than female infants in the form of being held, and stimulated (Sears et. al., 1957). However, this trend reverses at 6 months of age, where mothers touch and handle girls more than boys (Clay, 1968; Kagan & Lewis, 1965). However, and important for the present purpose, neither Will,

Self, and Datan (1976), nor Wasserman and Lewis (1985) found significant sex differences in the amount of maternal touch received during a free play session.

These mixed findings may be explained in different ways. For one, the age of the child matters. Depending on the age of the children tested, there may or may not be sex effects on the amount of maternal touch received. Additionally, it seems that the level of interaction requested of the mother under experimental settings matter. Wasserman and Lewis (1982) concluded that the style of maternal-child interaction changes drastically depending on whether mothers are asked to interact freely with their child, or to remain as an observer. These results were confirmed by Clarke-Stewart (1973), as well as by Weinraub and Frankel (1977), all of whom observed no sex differences during free play between mother and child. However, Goldberg and Lewis (1969) observed that there were sex differences observed in the amount of maternal touch received in studies where mothers were told to watch their child play, only to respond unless their child reaches out to them. Since this study employed a similar methodology to that used by Clarke-Stewart (1973), and Weinraub and Frankel (1977), where mothers were requested to interact with their children as they would at home in a free play session, it is not surprising that there were no sex differences observed in the amount of maternal touch received.

4.3 Maternal Speech

Overall, mothers spoke less frequently to older than younger children but used more grammatically complex constructions. The results obtained for maternal speech frequency parallels our observations for maternal touch

frequency, and may be interpreted in a similar way. In other words, mothers engaged with younger children more frequently than older children by both touching and speaking to them.

The results obtained for maternal utterance length may reflect the mothers' efforts to adjust their own language to the competency of their child. In line with these results, present and previous research found a drastic improvement in the complexity of verbal utterances from two to five years of age. Moreover, as was the case here, others have found this improvement to be mirrored in the parent's speech. For example, Fraser and Roberts (1973), among others, found that mothers spoke more simply and were more redundant with younger as compared to older children (Broen, 1972; Snow, 1972; Philips, 1973; Fraser & Roberts, 1975; Reichle, Longhurst & Stepanich, 1976). Presumably, these modifications produced by the mother aid the child in understanding and learning language (Snow, 1972).

In addition to an effect of age on the length of maternal utterances, mothers also adjusted their speech based on the sex of the child and on observation order. Mothers spoke in longer utterances when the play session came second as compared to when the play session came first for boys, but not for girls. These findings compare to those of Cherry and Lewis (1976), who found that mothers encouraged verbalization, and placed greater demands on their girls in becoming involved in conversational exchanges as compared to boys (Cherry & Lewis, 1976). Thus, it is possible that mothers are more sensitive when conversing with boys. In the present case, they may have given boys more

opportunity to acclimatize before challenging them with their speech. Additionally, boys may have been more ready to verbally engage with their mothers after going through the book session first.

4.4 Relationship Among Maternal Behaviors

As detailed above, mothers adjusted their behavior to their child's age. Hence it is not surprising that the relationship among the maternal behaviors also differed for the two age groups. In 2 year old children only, there was a significant positive relationship between instrumental maternal touch and maternal speech frequency. It is possible that the 2 year olds needed more active care than the 5 year olds, and mothers provided this care both through tactile and vocal channels.

Support for this notion comes from research that observed that the co-occurrence between speech and gesture changes with respect to speaking to young children as compared to that with adults. Iverson and colleagues (1999) suggests that mothers may use gesture with their children as a means to highlight and reinforce aspects of their verbal messages. In addition to using motherese in speech, a "gestural motherese" was also employed (Iverson, Capirci, Longobardi, and Caselli, 1999). This was characterized by relatively simpler gestures that co-occurred with verbal motherese, and was used to reinforce verbal messages (Iverson et. al., 1999).

This study observed that between 2 and 5 years of age, the frequency of both instrumental maternal touch and child directed utterances decreases, and with this, their positive relationship disappears. Instead, we now see a link

between instrumental and incidental touch on the one hand, and between incidental touch and speech complexity on the other hand. These findings largely replicate a similar study on Asian children by Reece and Schirmer (under review). As with the results obtained in this thesis, Reece and Schirmer (under review) found that instrumental touch was unrelated to the frequency of vocalizations, but was related to incidental touch for mothers of 4 to 6 year olds.

Together with the present results, observing a positive relationship between the maternal speech frequency and touch for younger children, but not for older ones, show that mothers indeed use both speech and touch as a way to care for and regulate their children's behavior. At an older age, however, children are more independent and need relatively less parental care (Carlson, 2005). As there exists evidence that gesture and speech often co-occur to form a single system of communication (Condon, 1976; Kendon, 1972, 1980; McNeill, 1985, 1987, 1992; Nobe, 1996), it is very likely that the co-occurrence of instrumental and incidental maternal touch for mothers of 5 year olds may simply be reflective of a physically affectionate mother who is more tactility involved with her child, such that she performs more touch overall by also choosing to sit close to her child.

Furthermore, the relationship between incidental maternal touch with maternal utterance length for the 5 year olds may reflect an increase in language skill in older children as compared to younger ones. Since gesture is often used to disambiguate speech (Holle & Gunter, 2007), the absence of the relationship between instrumental maternal touch and maternal utterance length demonstrate

that older children may perhaps be more able to understand the mother's verbal instructions such that she does not need to employ touch to substantiate her speech.

4.5 Relationship Between Maternal Behaviors and Child Speech

Unexpectedly, our study did not find a positive relationship between maternal touch and child speech for both the 2 year olds and the 5 year olds. In fact, there was a significant negative correlation between both incidental and instrumental maternal touch with child speech frequency for children in both age groups. However, when maternal touch behaviors were examined according to their subtypes, there was a significant negative relationship between the subtype "holding" and child mean length utterance for the 2 year olds. There was also a marginal significant negative relationship between the instrumental touch subtype "pushing" and child mean length utterance for the 5 year olds.

Based on existing work, we had earlier speculated that maternal touch is critical not only for motor, cognitive and social aspects of child development, but also for language more specifically. The failure to support this speculation may have several reasons.

One such reason is that in the context of interpersonal communication, maternal touch first and foremost promotes socio-emotional modes of responding and emphasizes non-verbal over verbal channels. In other words, the mother's touch may encourage a child to attend to her and to engage with her through eye-gaze, an affective vocal tone or reciprocal touch. Any potential effects on the

child's language development may be secondary, and only crystallize later in life once the individual can build on established nonverbal processes.

This explanation is in line with existing theories on scaffolding, which postulate that certain early sensorimotor experiences serve as building blocks for later development (Williams, Huang, & Bargh, 2009). An example for this is the existing association between affection and warm temperatures that arises from infancy (Lakoff & Johnson, 1980), where being held close to a loving parent also allows the child to experience bodily warmth. As such, the common use of terms to describe temperature in indicating the friendliness of another person reflects the scaffolding relationship between the sensation of physical temperature and psychological feelings, and also illustrates how incidental physical experiences shape the representation of abstract concepts (Williams et. al., 2009). Along these lines, maternal touch could promote nonverbal sensitivities in the child that may serve as scaffolding for later linguistic competencies.

The idea that parental touch first and foremost affects the child's non-verbal responding is supported by an analysis of the present data exploring whether and how maternal touch relates to child touch. The positive relationship that was observed between mother and child instrumental touching in 5 year olds supports the notion that maternal nonverbal behaviors promote similar non-verbal behaviors in children.

Additionally, there is much evidence from other research that suggests a relationship between touch and nonverbal behavior. Animal studies show that touch reduces the expression of negative emotions, and promotes the expression

of positive or pro-social emotions (Gonzalez, Lovic, Ward, Wainwright, & Fleming, 2001; Schirmer, Jesuthasan, & Mathuru, 2013). Moreover, research in humans shows a similar pattern of results, where touch seems to serve as a means of non-verbal communication. As compared to no-touch conditions, people who were touched had a greater tendency to be more compliant to requests (Willis & Hamm 1980; Hornik & Ellis, 1989), and to think more positively of the one who touched them (Patterson, Powell, & Lenihan, 1986). It could be the case that we share with other animals a tendency to associate the act of being touched with close social relationships (Kurzban, 2001), leading to more cooperative behavior, and a greater propensity to have warm feelings even towards strangers.

Notably, the present study found that apart from certain kinds of instrumental touch, maternal speech frequency and child speech frequency were significantly and marginally negatively related for children aged 2 and 5 years, respectively. A possible explanation is that a mother who touches and speaks too much to her child leaves the child with little chance to respond, and to develop a certain degree of linguistic sophistication. In line with this, the sub-types of touch that were found to relate negatively with child speech were "holding" and "pushing". These actions are largely restrictive actions that prevent or modify an intended action by the child. Alternatively, it is also possible that a mother who observes her child speaking very little, especially in an observational setting, may interpret the child's silence as a call for support and comfort. As such, she may choose to touch and speak to her child more often in order to prompt a response.

Unfortunately, as our study is correlational in nature, we are unable to discriminate between these two possibilities.

Although the present study found no support for the hypothesis that the frequency of maternal touch and speech aid in child speech development, there was indication that maternal speech complexity could be beneficial. Specifically, our study observed that the length of maternal utterances was positively correlated with the length of child utterances in 2 year olds, but not in 5 year olds. Together with comparable results from previous work (Furrow, Nelson, Benedict, 1979), these findings suggest that mothers can promote language development in young children through scaffolding. By using more complex speech than what the child is currently capable of, the mother pushes the child's existing grammatical limits during communication to aid in the child's language development.

4.6 Limitations and Future Directions

This thesis sought to support the idea that maternal touch directly contributes to the development of language competencies in children. The results obtained, however, reject this possibility and instead imply that touch de-emphasizes verbal communication in the short term. Moreover, by emphasizing nonverbal communication it may affect language development only indirectly and later in life through scaffolding processes. As these interpretations are post-hoc, they require further scrutiny in future research. To this end, one could re-examine the participants who have taken part in this study. After a few years, their speech and language could be assessed and brought in relation to their mother's as well as their own behavior as documented here.

Additionally, it would be useful to re-examine existing data and to obtain a time course analysis of child touch, maternal touch, child speech, and maternal speech. As maternal speech and touch do not occur independently of child behaviors, perhaps child-initiated touch and mother-initiated touch could be tracked in time to study whether maternal behaviors are produced in response to the child's behavior, or vice versa. This would be a more sophisticated approach than the one taken here and could provide more accurate insights into the functionality of maternal touch and speech.

Much research points to bi-directionality in mother-child interactions. For example, while child temperament affects parental behavior (examples in Maccoby & Martin, 1983), parental behavior also influences child temperament (Thomas & Chess, 1977, 1980). Wasserman and Lewis (1985) observed that infants who touched their mother more experienced more maternal touch in turn. Perhaps a quiet child is encouraged to speak when the mother touches the child, or prompts her with questions, or that the child reaches out to her mother in response to being spoken to. Wasserman and Lewis (1985) observed that infant touching, looking, and proximity seeking were significantly associated with maternal vocalization in experimental conditions where mothers were instructed to only interact with their children if they were sought out. As well, Snow (1972) observed that mothers modified their speech less when speaking to children whose reactions were hidden, suggesting that the child may play some role in regulating how their parents interact with them. From these findings, it is likely that responsive and non-responsive maternal touch play different roles in child

development, as such studying the patterns of touch between mother and child may provide further insights to the long and short term effects of maternal touch on child language development.

A further limitation of this thesis is that insights obtained are only correlational, and that conclusions on the direction of relationships cannot be made. Of note, however, causal relationships in human development are difficult to study. It is not ethical to conduct a true cause-and-effect experiment on maternal touch and child speech development. It is impossible to have one group of mothers deprive their children of touch in order to observe any long or short term consequences on child language development. Instead, future work could involve training one group of mothers on tactile interactions, and require them to record a touch diary with their child, while the other group will be trained on how to vocally interact with their child as a control. In this way, causal relationships may be discerned.

Finally, this study was only able to estimate a child's experience of everyday touch in the play session, and such an experience under experimental conditions may differ from maternal-child interactions at home. One possible solution to this problem could involve installing video cameras in the common areas of the home in order to capture a longer time period of mother-child interactions in the natural home environment. However, even this method has its drawbacks. In addition to being expensive and time consuming, parents may be unwilling to oblige and feel intruded upon in their home.

4.7 Conclusions

In conclusion, our results failed to identify a positive relationship between maternal touch and child speech behavior. Instead, the linguistic complexity of maternal speech seemed to be the only positive predictor for how children spoke. Moreover, a negative relationship between maternal touch and the frequency of child utterances on the one hand, and a positive relationship between maternal touch and child touch on the other hand hinted at the possibility that in the short term, touch could emphasize non-verbal over verbal communication. Thus, a possible role for language may be indirect and emerge only later in life through scaffolding processes.

Future research is necessary to substantiate these interpretations by examining language development longitudinally, by studying the time-based reciprocity between maternal and child behaviors, and by pursuing a causal rather than a correlational approach.

References

Ainsworth, M. D. & Bell, S. M. (1970), Attachment, exploration, and separation: Illustrated by the behavior of one-year-olds in a strange situation. *Child Development*, 41:49-67

Ainsworth, M. S. (1979). Infant–mother attachment. *American psychologist*, *34*(10), 932.

Anisfeld, E., Casper, V., Nozyce, M., & Cunningham, N. (1990). Does infant carrying promote attachment? An experimental study of the effects of increased physical contact on the development of attachment. *Child development*, *61*(5), 1617-1627.

Egeland, B., & Farber, E. A. (1984). Infant-mother attachment: Factors related to its development and changes over time. *Child development*, 753-771.

Baldwin, D. A. (1995). *Joint attention: Its origins and role in development*. Lawrence Erlbaum Associates, Inc. PsycINFO Database Record.

Barnes, S., Gutfreund, M., Satterly, D., & Wells, G. (1983). Characteristics of adult speech which predict children's language development. *Journal of child language*, *10*(1), 65-84.

Bayley, N., & Schaefer, E. S. (1964). Correlations of maternal and child behaviors with the development of mental abilities: Data from the Berkeley Growth Study. *Monographs of the Society for Research in Child Development*, 1-80.

Berlin, L. J., Brooks-Gunn, J., Spiker, D., & Zaslow, M. J. (1995). Examining Observational Measures of Emotional Support and Cognitive Stimulation

in Black and White Mothers of Preschoolers. *Journal of Family Issues*, *16*(5), 664-686

Bornstein, M. H., & Tamis-LeMonda, C. S. (1989). Maternal responsiveness and cognitive development in children. *New Directions for Child and Adolescent Development*, *1989*(43), 49-61.

Bornstein, M. H., Hahn, C. S., & Haynes, O. M. (2004). Specific and general language performance across early childhood: Stability and gender considerations. *First Language*, *24*(3), 267-304.

Bowlby, J. (1958). The nature of the child's tie to his mother. *International Journal of Psychoanalysts*, 39(5), 350-73.

Bowlby, J. (1977). The making and breaking of affectional bonds. I. Aetiology and psychopathology in the light of attachment theory. An expanded version of the Fiftieth Maudsley Lecture, delivered before the Royal College of Psychiatrists, 19 November 1976. *The British Journal of Psychiatry*, *130*(3), 201-210.

Broen, P. A. (1972). The Verbal Environment of the Language-Learning Child. ASHA Monographs, No. 17.

Brooks, R., & Meltzoff, A. N. (2005). The development of gaze following and its relation to language. *Developmental science*, *8*(6), 535-543.

Carlson, S. M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental neuropsychology*, *28*(2), 595-616.

Charman, T., Baron-Cohen, S., Swettenham, J., Baird, G., Cox, A., & Drew, A. (2000). Testing joint attention, imitation, and play as infancy precursors to language and theory of mind. *Cognitive Development*, *15*(4), 481-498.

Champagne, F. A. (2008). Epigenetic mechanisms and the transgenerational effects of maternal care. *Frontiers in neuroendocrinology*, *29*(3), 386-397.

Champagne, F. A., & Meaney, M. J. (2007). Transgenerational effects of social environment on variations in maternal care and behavioral response to novelty. *Behavioral neuroscience*, *121*(6), 1353.

Cherry, L., & Lewis, M. (1976). Mothers and two-year-olds: A study of sex-differentiated aspects of verbal interaction. *Developmental Psychology*, *12*(4), 278.

Clarke-Stewart, K. A. (1973). Interactions between mothers and their young children: Characteristics and consequences. *Monographs of the society for research in child development*, 1-109.

Clay, V.S. (1968). The effect of culture on mother-child tactile communication. *Family coordinator,* 204-210

Condon, W. S. (1988). An analysis of behavioral organization. *Sign Language Studies*, *58*(1), 55-88

Cox, F. N., & Campbell, D. (1968). Young children in a new situation with and without their mothers. *Child Development*, 123-131.

Cross, T. G. (1978). Mothers' speech and its association with rate of linguistic development in young children. In N. Waterson & C. Snow (Eds.), *The development of communication.* Chichester, U.K.: Wiley.

Crowell, J. A., & Feldman, S. S. (1988). Mothers' internal models of relationships and children's behavioral and developmental status: A study of mother-child interaction. *Child development*, 1273-1285.

Cusson, R. M. (2003). Factors influencing language development in preterm infants. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, *32*(3), 402-409.

Dale, P. S., Bates, E., Reznick, J. S., & Morisset, C. (1989). The validity of a parent report instrument of child language at twenty months. *Journal of child language*, *16*(02), 239-249.

Dale, P. S., Dionne, G., Eley, T. C., & Plomin, R. (2000). Lexical and grammatical development: A behavioural genetic perspective. *Journal of child language*, *27*(3), 619-642.

DeCasper, A. J., & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. *Science*, *208*(4448), 1174-1176.

Feldman, H. M., Dollaghan, C. A., Campbell, T. F., Kurs-Lasky, M., Janosky, J. E., & Paradise, J. L. (2000). Measurement properties of the MacArthur communicative development inventories at ages one and two years. *Child Development, 71*(2), 310–322.

Feldman, R., Weller, A., Sirota, L., & Eidelman, A. I. (2003). Testing a family intervention hypothesis: the contribution of mother-infant skin-to-skin

contact (kangaroo care) to family interaction, proximity, and touch. *Journal of Family Psychology*, *17*(1), 94.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. Monographs of the Society for Research in Child Development, 59, 1–185.

Ferber, S. G., Feldman, R., & Makhoul, I. R. (2008). The development of maternal touch across the first year of life. *Early Human Development*, *84*(6), 363-370.

Ferber, S. G., & Makhoul, I. R. (2004). The effect of skin-to-skin contact (kangaroo care) shortly after birth on the neurobehavioral responses of the term newborn: a randomized, controlled trial. *Pediatrics*, *113*(4), 858-865.

Fernald, A., & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental psychology*, *20*(1), 104.

Field T, Hernandez-Reif M, Freedman J. Stimulation programs for preterm infants. *Social Policy Report.* 2004;18:1–19.

Fisher, J. D., Rytting, M., & Heslin, R. (1976). Hands touching hands: Affective and evaluative effects of an interpersonal touch. *Sociometry*, 416-421.

Fisher, S. E., Lai, C. S., & Monaco, A. P. (2003). Deciphering the genetic basis of speech and language disorders. *Annual review of neuroscience*, *26*(1), 57-80.

Franco, F., Fogel, A., Messinger, D. S., & Frazier, C. A. (1996). Cultural differences in physical contact between Hispanic and Anglo mother–

infant dyads living in the United States. *Early development and Parenting*, *5*(3), 119-127.

Fraser, C., & Roberts, N. (1975). Mothers' speech to children of four different ages. *Journal of psycholinguistic research*, *4*(1), 9-16.

Furrow, D., Nelson, K., & Benedict, H. (1979). Mothers' speech to children and syntactic development: Some simple relationships. *Journal of child language*,*6*(03), 423-442.

Gallace, A., & Spence, C. (2010). The science of interpersonal touch: an overview. *Neuroscience & Biobehavioral Reviews*, *34*(2), 246-259.

Ganger, J., Pinker, S., Chawla, S., & Baker, A. (2002). Heritability of early milestones of vocabulary and grammar: A twin study. *Unpublished manuscript.*

Goldberg, S., & Lewis, M. (1969). Play behavior in the year-old infant: Early sex differences. *Child Development*, *40*(1), 21-31.

Gonzalez, A., Lovic, V., Ward, G. R., Wainwright, P. E., & Fleming, A. S. (2001). Intergenerational effects of complete maternal deprivation and replacement stimulation on maternal behavior and emotionality in female rats. *Developmental psychobiology*, *38*(1), 11-32.

Green, J. R., & Wilson, E. M. (2006). Spontaneous facial motility in infancy: A 3D kinematic analysis. *Developmental psychobiology*, *48*(1), 16-28.

Griffiths, R. (Ed.). (1970). *The abilities of young children. A comprehensive system of mental measurement for the first eight years*. High Wycombe: The Test Agency.

Grossmann, K., Thane, K., & Grossmann, K. E. (1981). Maternal tactual contact of the newborn after various postpartum conditions of mother–infant contact. *Developmental Psychology*, *17*(2), 158.

Grossmann, K., Grossmann, K. E., Spangler, G., Suess, G., & Unzner, L. (1985). Maternal sensitivity and newborns' orientation responses as related to quality of attachment in northern Germany. *Monographs of the Society for Research in Child Development*, 233-256.

Guéguen, N. (2002). Touch, awareness of touch, and compliance with a request. *Perceptual and motor skills*, *95*(2), 355-360.

Guzzetta, A., Baldini, S., Bancale, A., Baroncelli, L., Ciucci, F., Ghirri, P., ... & Maffei, L. (2009). Massage accelerates brain development and the maturation of visual function. *The Journal of Neuroscience*, *29*(18), 6042-6051.

Haubrich, K. (1998). Assessment and management of auditory dysfunction. In C.Kenner, J.Lott, & A.Flandemeyer (Eds.), *Comprehensive neonatal nursing: A physiologic perspective* (pp. 682–712). Philadelphia: W. B. Saunders.

Heathers, G. (1954). The adjustment of two-year-olds in a novel social situation. *Child development*, 147-158.

Herrera, E., Reissland, N., & Shepherd, J. (2004). Maternal touch and maternal child-directed speech: effects of depressed mood in the postnatal period. *Journal of Affective Disorders*, *81*(1), 29-39.

Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child development*, *74*(5), 1368-1378.

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review*, *26*(1), 55-88.

Holditch-Davis, D., Bartlett, T. R., & Belyea, M. (2000). Developmental problems and interactions between mothers and prematurely born children. *Journal of Pediatric Nursing*, *15*(3), 157-167.

Holle, H., & Gunter, T. C. (2007). The role of iconic gestures in speech disambiguation: ERP evidence. *Journal of cognitive neuroscience*, *19*(7), 1175-1192.

Hornik, J., & Ellis, S. (1989). Strategies to secure compliance for a mall intercept interview. *Public Opinion Quarterly*, **52**, 539–551.

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early growth: Relation to language input and gender. *Developmental Psychology*, *27*(2), 236-248.

Hyde, J. S., & Linn, M. C. (1988). Gender differences in verbal ability: A meta-analysis. *Psychological Bulletin*, *104*(1), 53.

IJzendoorn, M. H., Dijkstra, J., & Bus, A. G. (1995). Attachment, Intelligence, and Language: A Meta-analysis. *Social development*, *4*(2), 115-128.

Iverson, J. M. (2010). Developing language in a developing body: The relationship between motor development and language development. *Journal of Child Language*, *37*(02), 229.

Iverson, J. M., Capirci, O., Longobardi, E., & Cristina Caselli, M. (1999). Gesturing in mother-child interactions. *Cognitive Development*, *14*(1), 57-75.

Jean, A. D., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior and Development*, *32*(3), 344-349.

Jung, M. J., & Fouts, H. N. (2011). Multiple caregivers' touch interactions with young children among the Bofi foragers in Central Africa. *International Journal of Psychology*, *46*(1), 24-32.

Kagan, J., & Lewis, M. (1965). Studies of attention in the human infant. *Merrill-Palmer Quarterly*, *11*, 95-127.

Kelmanson, I., & Adulas, E. (2009). Massage interventions and developmental skills in infants born with low birth weight. *Early Child Development and Care*, *179*(7), 889-897.

Kendon, A. (1972). Some relationships between body motion and speech. *Studies in dyadic communication*, *7*, 177.

Kendon, A. (1980). Gesticulation and speech: Two aspects of the process of utterance. *The relationship of verbal and nonverbal communication*, *25*, 207-227.

Kendon, A. (1997). Gesture. *Annual review of anthropology*, 109-128.

Kramer, J. H., Delis, D. C., & Daniel, M. (1988). Sex differences in verbal learning. *Journal of Clinical Psychology*, *44*(6), 907-915.

Krippendorff, K. 1980. *Content analysis: An introduction to its methodology*, Beverly Hills, CA: Sage.

Kurzban, R. (2001). The social psychophysics of cooperation: Nonverbal communication in a public goods game. *Journal of Nonverbal Behavior*, *25*(4), 241-259.

Laakso, M., Poikkeus, A., Eklund, K., & Lyytinen, P. (1999). Social interactional behaviors and symbolic play competencies as predictors of language development and their associations with maternal attention-directing strategies. *Infant Behavior and Development*, *22*(4), 541-556.

Lakoff, G., & Johnson, M. (1980). The metaphorical structure of the human conceptual system. *Cognitive Science*, *4*(2), 195-208.

Leaper, C., & Smith, T. E. (2004). A meta-analytic review of gender variations in children's language use: talkativeness, affiliative speech, and assertive speech. *Developmental Psychology*, *40*(6), 993.

Lee, H., & Barratt, M. S. (1993). Cognitive development of preterm low birth weight children at 5 to 8 years old. *Journal of Developmental & Behavioral Pediatrics*, *14*(4), 242-249.

Lenneberg, E.H. (1967). Biological foundations of language. *Wiley, New York* (1967)

Lenneberg, E. H. (1969). On explaining language. *Science*, *164*, 635-643.

Löken, L. S., Wessberg, J., McGlone, F., & Olausson, H. (2009). Coding of pleasant touch by unmyelinated afferents in humans. *Nature neuroscience*,*12*(5), 547-548.

Lyytinen, P., Poikkeus, A. M., Leiwo, M., Ahonen, T., & Lyytinen, H. (1996). Parents as informants of their child's vocal and early language development. *Early Child Development and Care*, *126*(1), 15-25

Lytton, H.. & Romncy. D.M. (1991). Parents' differential socialization of boys and girls: A meta-analysis. *Psychological Bulletin. 109.* 267-296.

Maccoby, E. E., & Jacklin, C. N. (Eds.). (1974). *The Psychology of Sex Differences* (Vol. 1). Stanford University Press.

Main, M., & Solomon, J. (1990). Procedures for identifying infants as disorganized/disoriented during the Ainsworth Strange Situation. *Attachment in the preschool years: Theory, research, and intervention*, *1*, 121-160.

Mayberry, R. I., Lock, E., & Kazmi, H. (2002). Development: Linguistic ability and early language exposure. *Nature*, *417*(6884), 38-38.

Meaney, M. J. (2001). Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annual Review of Neuroscience*, *24*(1), 1161-1192.

McCarthy, D. (1953). Some possible explanations of sex differences in language development and disorders. *The Journal of Psychology*, *35*(1), 155-160.

McClave, E. (1991). *Intonation and gesture*. Unpublished doctoral dissertation, Georgetown University, Washington, DC

McGraw, K. O., & Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychological methods*, *1*(1), 30.

McNeill, D. 1985. So You Think Gestures are Non-Verbal? *Psychological Review, 92,* 350-371.

McNeill, D. (1987). *Psycholinguistics*. New York: Harper & Row.

McNeill, D. 1992. *Hand and Mind: What Gestures Reveal About Thought.* Chicago: University of Chicago Press.

Mendel, G. (1965). Children's preferences for differing degrees of novelty. *Child Development*, 453-465.

Moore, T. (1968). Language and intelligence: A longitudinal study of the first eight years. *Human development*, *11*(1), 1-24.

Moore, C., & Dunham, P. J. (1995). Current Themes in Research on Joint Attention. *Joint attention: Its origins and role in development* (pp. 15-27). Hillsdale, N.J.: Lawrence Erlbaum Associates.

Moreno, A. J., Posada, G. E., & Goldyn, D. T. (2006). Presence and quality of touch influence coregulation in mother-infant dyads. *Infancy*, *9*(1), 1-20.

Mullen, E. M. (1995). *Mullen scales of early learning* (pp. 58-64). Circle Pines, MN: AGS.

Mundy, P., & Gomes, A. (1998). Individual differences in joint attention skill development in the second year. *Infant behavior and development*, *21*(3), 469-482.

Murray, A. D., Johnson, J., & Peters, J. (1990). Fine-tuning of utterance length to preverbal infants: Effects on later language development. *Journal of Child Language*, *17*(03), 511-525.

Murray, A. D., & Yingling, J. L. (2000). Competence in language at 24 months: Relations with attachment security and home stimulation. *The Journal of Genetic Psychology, 161*(2), 133-140.

Neu, M., & Robinson, J. (2010). Maternal holding of preterm infants during the early weeks after birth and dyad interaction at six months. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *39*(4), 401-414.

Nienhuys, T. G., Cross, T. G., & Horsborough, K. M. (1984). Child variables influencing maternal speech style: Deaf and hearing children. *Journal of communication disorders*, *17*(3), 189-207.

Nip, I. S., Green, J. R., & Marx, D. B. (2009). Early speech motor development: Cognitive and linguistic considerations. *Journal of communication disorders*,*42*(4), 286-298.

Nobe, S. (2000). Where do most spontaneous representational gestures actually occur with respect to speech. *Language and gesture*, *2*, 186.

Olausson, H., Vallbo, Ã., Bushnell, M., Worsley, K., Strigo, I., Ekholm, S., et al. (2002). Unmyelinated tactile afferents signal touch and project to insular cortex. *Nature Neuroscience*, *5*(9), 900-904.

Olson, R., Wise, B., Conners, F., Rack, J., & Fulker, D. (1989). Specific deficits in component reading and language skills Genetic and environmental influences. *Journal of learning disabilities*, *22*(6), 339-348.

Pattison, J. E. (1973). Effects of touch on self-exploration and the therapeutic relationship. *Journal of Consulting and Clinical Psychology*, *40*(2), 170.

Papoušek, M., Papoušek, H., & Symmes, D. (1991). The meanings of melodies in motherese in tone and stress languages. *Infant Behavior and Development,14*(4), 415-440.

Patterson, M. L., Powell, J. L., & Lenihan, M. G. (1986). Touch, compliance, and interpersonal affect. *Journal of Nonverbal Behavior*, *10*(1), 41-50.

Paul, R., Looney, S. S., & Dahm, P. S. (1991). Communication and socialization skills at ages 2 and 3 in late-talking young children. *Journal of Speech, Language, and Hearing Research*, *34*(4), 858-865.

Pfeiffer, S. I., & Aylward, G. P. (1990). Outcome for preschoolers of very low birthweight: Sociocultural and environmental influences. *Perceptual and Motor Skills*, *70*(3c), 1367-1378.

Phillips, J. R. (1973). Syntax and vocabulary of mothers' speech to young children: Age and sex comparisons. *Child development*, 182-185.

Polan, H. J., & Ward, M. J. (1994). Role of the mother's touch in failure to thrive: A preliminary investigation. *Journal of the American Academy of Child & Adolescent Psychiatry*, *33*(8), 1098-1105.

Reece, C.E.; Schirmer, A. (under review). *Maternal Touch Relates to Face Sensitivity in Children.*

Reichle, J. E., Longhurst, T. M., & Stepanich, L. (1976). Verbal interaction in mother-child dyads. *Developmental psychology*, *12*(4), 273.

Reznick, J. S., Corley, R., Robinson, J., & Matheny Jr, A. P. (1997). A longitudinal twin study of intelligence in the second year. *Monographs of the Society for Research in Child Development*, i-160.

Saarni, C. (1984). An observational study of children's attempts to monitor their expressive behavior. *Child Development*, 1504-1513.

Sears, R. R., Maccoby, E. E., & Levin, H. T. (1957). *Patterns of Child Rearing: A Report on Ways of Bringing Up Children*. Row Peterson.

Schegloff, E. A. (1987). Analyzing single episodes of interaction: An exercise in conversation analysis. *Social psychology quarterly*, 101-114.

Schirmer, A., Jesuthasan, S., & Mathuru, A. S. (2013). Tactile stimulation reduces fear in fish. *Frontiers in behavioral neuroscience*, *7*.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: uses in assessing rater reliability. *Psychological bulletin*, *86*(2), 420.

Smith, L., Ulvund, S. E., & Lindemann, R. (1994). Very low birth weight infants (< 1501 g) at double risk. *Journal of Developmental & Behavioral Pediatrics*,*15*(1), 7-13.

Snow, C. E. (1972). Mothers' speech to children learning language. *Child development*, 549-565.

Stoel-Gammon, C. (1989). Prespeech and early speech development of two late talkers. *First Language*, *9*(6), 207-223.

Stromswold, K. (2005). Genetic specificity of linguistic heritability. *Twenty-first century psycholinguistics: Four cornerstones*, 121-140.

Tamis-LeMonda, C., Bornstein, M. H., & Baumwell, L. (2003). Maternal responsiveness and children's achievement of language milestones. *Child Development, 72*(3), 748-767.

Tessier, R., Cristo, M. B., Velez, S., Giron, M., Nadeau, L., Figueroa de Calume, Z., Ruiz-Paláez, J.G., & Charpak, N. (2003). Kangaroo Mother Care: A method for protecting high-risk low-birth-weight and premature infants against developmental delay. *Infant Behavior and Development*, *26*(3), 384-397.

Thelen, E. (1991). Motor aspects of emergent speech: A dynamic approach. *Biological and behavioral determinants of language development*, 339-362.

Tomasello, M. (1988). The role of joint attentional processes in early language development. *Language Sciences*, *10*(1), 69-88.

Tomblin, J. B., & Buckwalter, P. R. (1998). Heritability of poor language achievement among twins. *Journal of Speech, Language, and Hearing Research*, *41*(1), 188-199.

Vickers, A., Ohlsson, A., Lacy, J. B., & Horsley, A. (2004). Massage for promoting growth and development of preterm and/or low birth-weight infants. *Cochrane Database Syst Rev*, *2*.

Visscher, C., Houwen, S., Scherder, E. J., Moolenaar, B., & Hartman, E. (2007). Motor profile of children with developmental speech and language disorders. *Pediatrics*, *120*(1), 158-163.

Wallentin, M. (2009). Putative sex differences in verbal abilities and language cortex: A critical review. *Brain and Language*, *108*(3), 175-183.

Wasserman, G. A., & Lewis, M. (1985). Infant sex differences: Ecological effects. *Sex roles*, *12*(5-6), 665-675.

Weerahandi, S. (1995). Generalized confidence intervals. In *Exact Statistical Methods for Data Analysis* (pp. 143-168). Springer New York.

Weinraub, M., & Frankel, J. (1977). Sex differences in parent-infant interaction during free play, departure, and separation. *Child Development*, 1240-1249.

Weiss, S. J. (1992). Measurement of the sensory qualities in tactile interaction. *Nursing Research*, *41*(2), 82-86.

Weiss, S. J., Wilson, P., Hertenstein, M. J., & Campos, R. (2000). The tactile context of a mother's caregiving: implications for attachment of low birth weight infants. *Infant Behavior and Development*, *23*(1), 91-111.

Weiss, S. J., Wilson, P., Seed, M. S., & Paul, S. M. (2001). Early tactile experience of low birth weight children: Links to later mental health and social adaptation. *Infant and Child Development*, *10*, 93-115.

Weiss, S., Wilson, P., & Morrison, D. (2004). Maternal tactile stimulation and the neurodevelopment of low birth weight infants. *Infancy*, *5*(1), 85-107.

Will, J. A., Self, P. A., & Datan, N. (1976). Maternal behavior and perceived sex of infant. *American Journal of Orthopsychiatry*, *46*(1), 135-139.

Wijaya & Schirmer (2014). The role of touch for the processing of social and non-social information. Manuscript in preparation.

Willis Jr, F. N., & Hamm, H. K. (1980). The use of interpersonal touch in securing compliance. *Journal of Nonverbal Behavior*, *5*(1), 49-55.

Williams, L. E., Huang, J. Y., & Bargh, J. A. (2009). The scaffolded mind: Higher mental processes are grounded in early experience of the physical world. *European Journal of Social Psychology*, *39*(7), 1257-1267.

Wulbert, M., Inglis, S., Kriegsmann, E., & Mills, B. (1975). Language delay and associated mother-child interactions. *Developmental Psychology*, *11*(1), 61-70.

Appendix A- Touch Coding Guidelines

1. **Terms for body parts for both Toucher and Touchee:**

    - Head (Includes neck)
    - Back (Includes side)
    - Backside
    - Arm (Includes shoulder)
    - Hand
    - Leg
    - Chest (Includes abdominal area)

2. **Terms for type of touch:**

    - Stroke: Two surfaces moving against each other (Includes brushes) Note: only Hand.
    - Hold: Grasping of hand (Includes pinch).
    - Bump: One momentary point of contact between two surfaces (Includes slaps and knocks) Note: All contact to be bump unless it involves Hands.
    - Push: Movement involving direction away from self (Includes nudges, tickles and pokes).
    - Pull: Movement involving direction towards self (Includes carry toward self).
    - Lean/Resting: Involves inclination of the body or One surface on top of another (Includes pressing and sitting on another)

3. **Categories of touch (To be coded for both mother and child):**

    - **Instrumental Touch**

        i. Supporting: Appears to <u>help</u>

ii. Inhibiting/Correcting: Actively changing or stopping the action of the other, not for the purpose of help.

iii. Attentional: Seeking attention of the other

iv. Cleaning/Fixing

v. Affectionate Touch: Intentional touch that gives an impression of closeness between mother and child. (Does not include incidental bumps that linger).

- **Incidental Touch**

  i. Touch that occurs by way of actions directed at another purpose other than the touch itself.

  ii. In the case of two body parts touching, code for the initial touch.

4. Additional notes:

- Indicate timestamps for all touch. List of timestamps to be sent to each other, without touch coding.
- In the case of abnormalities (i.e. Mother or child leaving the view of the camera), indicate what happened, and its start and end according to the time stamp, under Notes.